

## CA3078

### *Micropower Operational Amplifier*

The CA3078 and CA3078A are high gain monolithic operational amplifiers which can deliver milliamperes of current yet only consume microwatts of standby power. Their operating points are externally adjustable and frequency compensation may be accomplished with one external capacitor. The CA3078 and CA3078A provide the designer with the opportunity to tailor the frequency response and improve the slew rate without sacrificing power. Operation with a single 1.5V battery is a practical reality with these devices.

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#### **Rochester Electronics Manufactured Components**

Rochester branded components are manufactured using either die/wafers purchased from the original suppliers or Rochester wafers recreated from the original IP. All recreations are done with the approval of the OCM.

Parts are tested using original factory test programs or Rochester developed test solutions to guarantee product meets or exceeds the OCM data sheet.

#### **Quality Overview**

- ISO-9001
- AS9120 certification
- Qualified Manufacturers List (QML) MIL-PRF-38535
  - Class Q Military
  - Class V Space Level
- Qualified Suppliers List of Distributors (QSLD)
  - Rochester is a critical supplier to DLA and meets all industry and DLA standards.

Rochester Electronics, LLC is committed to supplying products that satisfy customer expectations for quality and are equal to those originally supplied by industry manufacturers.

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*The original manufacturer's datasheet accompanying this document reflects the performance and specifications of the Rochester manufactured version of this device. Rochester Electronics guarantees the performance of its semiconductor products to the original OEM specifications. 'Typical' values are for reference purposes only. Certain minimum or maximum ratings may be based on product characterization, design, simulation, or sample testing.*

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## Micropower Operational Amplifier

### Features

- Low Standby Power..... As Low As 700nW
- Wide Supply Voltage Range.....  $\pm 0.75V$  to  $\pm 15V$
- High Peak Output Current..... 6.5mA min.
- Adjustable Quiescent Current
- Output Short Circuit Protection

### Applications

- Portable Electronics
- Medical Electronics
- Instrumentation
- Telemetry
- Intrusion Alarms

### Description

The CA3078 and CA3078A are high gain monolithic operational amplifiers which can deliver milliamperes of current yet only consume microwatts of standby power. Their operating points are externally adjustable and frequency compensation may be accomplished with one external capacitor. The CA3078 and CA3078A provide the designer with the opportunity to tailor the frequency response and improve the slew rate without sacrificing power. Operation with a single 1.5V battery is a practical reality with these devices.

The CA3078A is a premium device having a supply voltage range of  $V_{\pm} = 0.75V$  to  $V_{\pm} = 15V$ . The CA3078 has the same lower supply voltage limit but the upper limit is  $V_{+} = +6V$  and  $V_{-} = -6V$ .

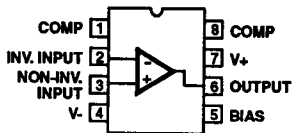
### Ordering Information

PART NUMBER	TEMPERATURE RANGE	PACKAGE
CA3078AE	-55°C to +125°C	8 Lead Plastic DIP
CA3078AM	-55°C to +125°C	8 Lead SOIC
CA3078AM96	-55°C to +125°C	8 Lead SOIC*
CA3078AT	-55°C to +125°C	8 Pin Can
CA3078E	0°C to +70°C	8 Lead Plastic DIP
CA3078M	0°C to +70°C	8 Lead SOIC
CA3078M96	0°C to +70°C	8 Lead SOIC*
CA3078T	0°C to +70°C	8 Pin Can

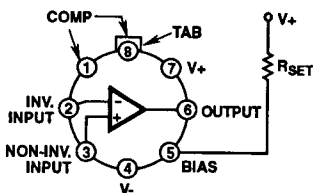
\* Denotes Tape and Reel

### Pinouts

CA3078 (PDIP, SOIC)  
TOP VIEW



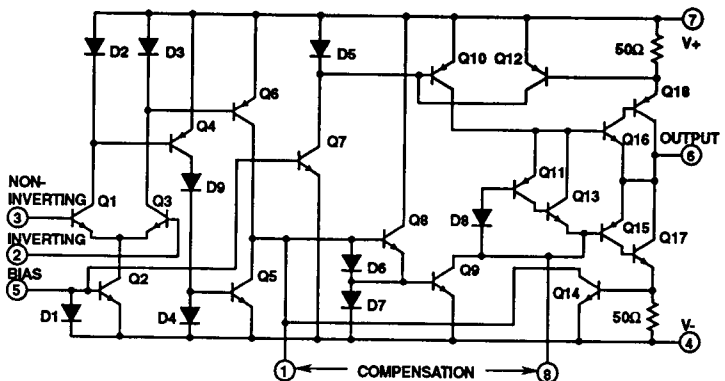
CA3078 (TO-5 CAN)  
TOP VIEW



NOTE: Pin 4 is connected to case.

### Schematic Diagram

CA3078 AND CA3078A



## Specifications CA3078, CA3078A

### Absolute Maximum Ratings $T_A = +25^\circ\text{C}$

Supply Voltage (Between V+ and V- Terminal)	
CA3078.....	14V
CA3078A.....	36V
Differential Input Voltage.....	6V
Input Voltage.....	V+ to V-
Input Current.....	0.1mA
Output Short Circuit Duration (Note 1).....	No Limitation
Junction Temperature.....	+175°C
Junction Temperature (Plastic Package).....	+150°C
Lead Temperature (Soldering 10 Sec.).....	+300°C

### Operating Conditions

Operating Temperature Range	
CA3078.....	0°C to +70°C
CA3078A.....	-55°C to +125°C
Storage Temperature Range.....	-65°C to +150°C

**CAUTION:** Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

### Electrical Specifications For Equipment Design

SYMBOL	TEST CONDITIONS			CA3078A LIMITS					CA3078 LIMITS					UNITS
				$R_{SET} = 5.1\text{M}\Omega$					$R_{SET} = 1\text{M}\Omega$					
	V+ and V-	$R_S$ (k $\Omega$ )	$R_L$ (k $\Omega$ )	$T_A = +25^\circ\text{C}$			$T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$		$T_A = +25^\circ\text{C}$			$T_A = 0^\circ\text{C}$ to $+70^\circ\text{C}$		
				MIN	TYP	MAX	MIN	MAX	MIN	TYP	MAX	MIN	MAX	
$V_{IO}$	$\pm 6\text{V}$	$\leq 10$	-	-	0.70	3.5	-	4.5	-	1.3	4.5	-	5	mV
$I_{IO}$		-	-	-	0.50	2.5	-	5.0	-	6	32	-	40	nA
$I_{IB}$		-	-	-	7	12	-	50	-	60	170	-	200	nA
$A_{OL}$		-	$\geq 10$	92	100	-	90	-	88	92	-	86	-	dB
$I_Q$		-	-	-	20	25	-	45	-	100	130	-	150	$\mu\text{A}$
$P_D$		-	-	-	240	300	-	540	-	1200	1560	-	1800	$\mu\text{W}$
$V_{OM}$		-	$\geq 10$	$\pm 5.1$	$\pm 5.3$	-	$\pm 5$	-	$\pm 5.1$	$\pm 5.3$	-	$\pm 5$	-	V
$V_{ICR}$		$\leq 10$	-	-	-5.5 to +5.8	-	-5 to +5	-	-	-5.5 to +5.8	-	-5 to +5	-	V
CMRR		$\leq 10$	-	80	115	-	-	-	80	110	-	-	-	dB
$I_{OM+}$ or $I_{OM-}$		-	-	-	12	-	6.5	30	-	12	-	6.5	30	mA
$\Delta V_{IO}/\Delta V_+$		$\leq 10$	-	76	105	-	-	-	76	93	-	-	-	$\mu\text{V}/\text{V}$
$\Delta V_{IO}/\Delta V_-$		$\leq 10$	-	76	105	-	-	-	76	93	-	-	-	$\mu\text{V}/\text{V}$
$R_{SET} = 13\text{M}\Omega$														
$V_{IO}$	$\pm 15\text{V}$	$\leq 10$	-	-	1.4	3.5	-	4.5	-	-	-	-	-	mV
$A_{OL}$		-	$\geq 10$	92	100	-	88	-	-	-	-	-	-	dB
$I_Q$		-	-	-	20	30	-	50	-	-	-	-	-	$\mu\text{A}$
$P_D$		-	-	-	600	750	-	1350	-	-	-	-	-	$\mu\text{W}$
$V_{OM}$		-	$\geq 10$	$\pm 13.7$	$\pm 14.1$	-	$\pm 13.5$	-	-	-	-	-	-	V
CMRR		$\leq 10$	-	80	106	-	-	-	-	-	-	-	-	dB
$I_{IB}$		-	-	-	7	14	-	55	-	-	-	-	-	nA
$I_{IO}$		-	-	-	0.50	2.7	-	5.5	-	-	-	-	-	nA

NOTE:

- Short circuit may be applied to ground or to either supply.

2  
OPERATIONAL AMPLIFIERS

## Specifications CA3078, CA3078A

**Electrical Specifications**  $T_A = +25^\circ\text{C}$ , Typical Values Intended Only for Design Guidance

SYMBOL	TYPICAL VALUES				UNITS
	CA3078A		CA3078		
	V+ = +1.3V, V- = -1.3V R <sub>SET</sub> = 2M $\Omega$	V+ = +0.75V, V- = -0.75V R <sub>SET</sub> = 10M $\Omega$	V+ = +1.3V, V- = -1.3V R <sub>SET</sub> = 2M $\Omega$	V+ = +0.75V, V- = -0.75V R <sub>SET</sub> = 10M $\Omega$	
V <sub>IO</sub>	0.7	0.9	1.3	1.5	mV
I <sub>IO</sub>	0.3	0.054	1.7	0.5	nA
I <sub>IB</sub>	3.7	0.45	9	1.3	nA
A <sub>OL</sub>	84	65	80	60	dB
I <sub>Q</sub>	10	1	10	1	$\mu\text{A}$
P <sub>D</sub>	26	1.5	26	1.5	$\mu\text{W}$
V <sub>OPP</sub>	1.4	0.3	1.4	0.3	V
V <sub>ICR</sub>	-0.8 to +1.1	-0.2 to +0.5	-0.8 to +1.1	-0.2 to +0.5	V
CMRR	100	90	100	90	dB
I <sub>OM</sub> $\pm$	12	0.5	12	0.5	mA
$\Delta V_{IO}/\Delta V\pm$	20	50	20	50	$\mu\text{V/V}$

**Electrical Specifications**  $T_A = +25^\circ\text{C}$  and V+ = +6V, V- = -6V, Typical Values Intended Only for Design Guidance

SYMBOL	TEST CONDITIONS	CA3078A		CA3078	UNITS
		R <sub>SET</sub> = 5.1M $\Omega$	R <sub>SET</sub> = 1M $\Omega$	R <sub>SET</sub> = 1M $\Omega$	
$\Delta V_{IO}/\Delta T_A$	R <sub>S</sub> $\leq$ 10k $\Omega$	5	6	6	$\mu\text{V}/^\circ\text{C}$
$\Delta I_{IO}/\Delta T_A$	R <sub>S</sub> $\leq$ 10k $\Omega$	6.3	70	70	pA/ $^\circ\text{C}$
BW <sub>OL</sub>	3dB pt.	0.3	2	2	kHz
SR	See Figures 18, 19	0.027	0.04	0.04	V/ $\mu\text{s}$
		0.5	1.5	1.5	V/ $\mu\text{s}$
t <sub>R</sub>	10% to 90% Rise Time	3	2.5	2.5	$\mu\text{s}$
R <sub>I</sub>	-	7.4	1.7	0.87	M $\Omega$
R <sub>O</sub>	-	1	0.8	0.8	k $\Omega$
e <sub>N</sub> (10Hz)	R <sub>S</sub> = 0	40	-	25	nV/ $\sqrt{\text{Hz}}$
i <sub>N</sub> (10Hz)	R <sub>S</sub> = 1M $\Omega$	0.25	-	1	pA/ $\sqrt{\text{Hz}}$

# CA3078, CA3078A

**TABLE 1. UNITY GAIN SLEW RATE vs COMPENSATION - CA3078 AND CA3078A**

Supply Volts:  $V_+ = +6$ ,  $V_- = -6$ , Output Voltage ( $V_O$ ) =  $\pm 5V$ , Load Resistance ( $R_L$ ) =  $10k\Omega$ , Transient Response: 10% overshoot for an output voltage of  $100mV$ , Ambient Temperature ( $T_A$ ) =  $+25^\circ C$

COMPENSATION TECHNIQUE	UNITY GAIN (INVERTING) FIGURE 22					UNITY GAIN (NON-INVERTING) FIGURE 23				
	$R_1$ k $\Omega$	$C_1$ pF	$R_2$ k $\Omega$	$C_2$ $\mu F$	SLEW RATE V/ $\mu s$	$R_1$ k $\Omega$	$C_1$ pF	$R_2$ k $\Omega$	$C_2$ $\mu F$	SLEW RATE V/ $\mu s$
CA3078 - $I_Q = 100\mu A$										
Single Capacitor	0	750	$\infty$	0	0.0085	0	1500	$\infty$	0	0.0095
Resistor & Capacitor	3.5	350	$\infty$	0	0.04	5.3	500	$\infty$	0	0.024
Input	$\infty$	0	0.25	0.306	0.67	$\infty$	0	0.311	0.45	0.67
CA3078A - $I_Q = 20\mu A$										
Single Capacitor	0	300	$\infty$	0	0.0095	0	800	$\infty$	0	0.003
Resistor & Capacitor	14	100	$\infty$	0	0.027	34	125	$\infty$	0	0.02
Input	$\infty$	0	0.644	0.156	0.29	$\infty$	0	0.77	0.4	0.4

## Operating Conditions

### Compensation Techniques

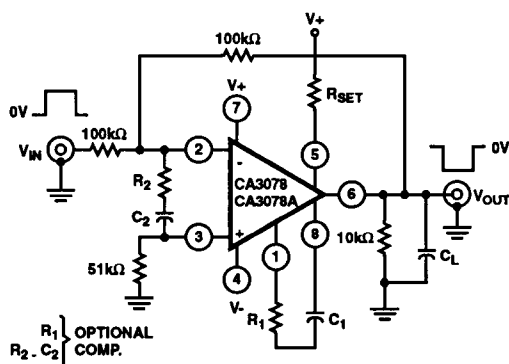
The CA3078A and CA3078 can be phase compensated with one or two external components depending upon the closed loop gain, power consumption, and speed desired. The recommended compensation is a resistor in series with a capacitor connected from Terminal 1 to Terminal 8. Values of the resistor and capacitor required for compensation as a function of closed loop gain are shown in Figures 20 and 21. These curves represent the compensation necessary at quiescent currents of  $100\mu A$  and  $20\mu A$ , respectively, for a transient response with 10% overshoot. Figures 18 and 19 show the slew rates that can be obtained with the two different compensation techniques. Higher speeds can be achieved with input compensation, but this increases noise

output. Compensation can also be accomplished with a single capacitor connected from Terminal 1 to Terminal 8, with speed being sacrificed for simplicity. Table 1 gives an indication of slew rates that can be obtained with various compensation techniques at quiescent currents of  $100\mu A$  and  $20\mu A$ .

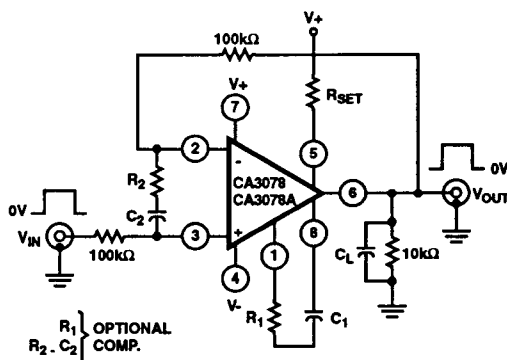
### Single Supply Operation

The CA3078A and CA3078 can operate from a single supply with a minimum total supply voltage of  $1.5V$ . Figures 25 and 26 show the CA3078A or CA3078 in inverting and non-inverting  $20dB$  amplifier configurations utilizing a  $1.5V$  type "AA" cell for a supply. The total consumption for either circuit is approximately  $675mW$ . The output voltage swing in this configuration is  $300mV_{p-p}$  with a  $20k\Omega$  load.

## Test Circuits



**FIGURE 22. TRANSIENT RESPONSE AND SLEW RATE, UNITY GAIN (INVERTING) TEST CIRCUIT**



**FIGURE 23. SLEW RATE, UNITY GAIN (NON-INVERTING) TEST CIRCUIT**

Test Circuits (Continued)

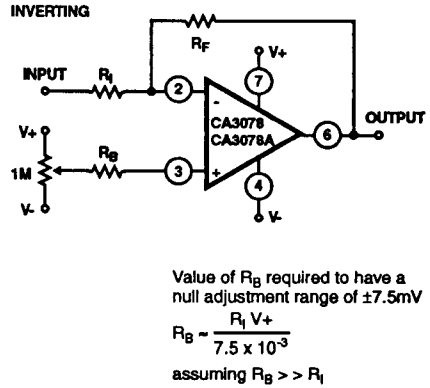
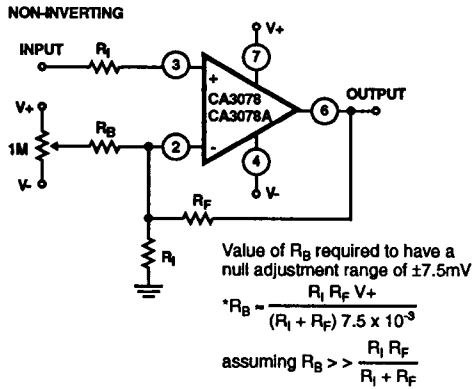


FIGURE 24. OFFSET VOLTAGE NULL CIRCUITS

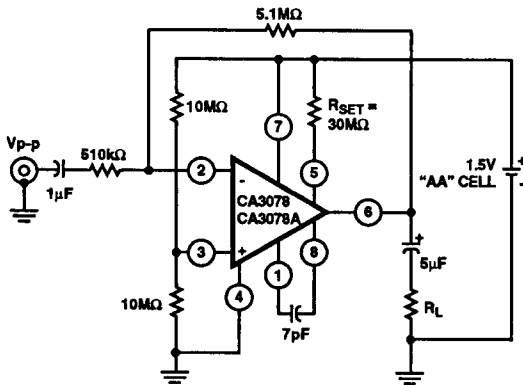


FIGURE 25. INVERTING 20dB AMPLIFIER CIRCUIT

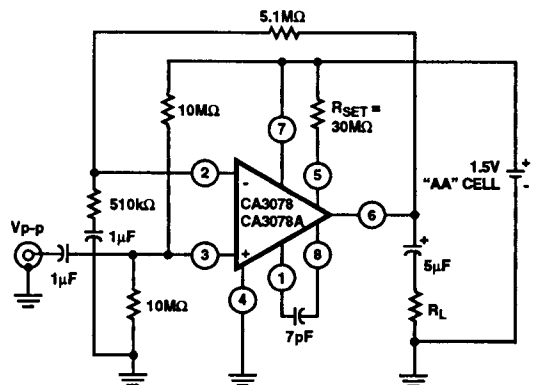


FIGURE 26. NON-INVERTING 20dB AMPLIFIER CIRCUIT